PETROGRAPHIC OBSERVATIONS AND CLASSIFICATION: IMPACTITES FROM THE YAXCOPOIL-1 BOREHOLE, CHICXULUB IMPACT STRUCTURE, YUCATÁN PENINSULA, MEXICO. M.G. Tuchscherer[1], (tuchscm@science.pg.wits.ac.za), W.U. Reimold[1], R.L. Gibson[1], and C. Koeberl[2], [1]Impact Cratering Research Group (I.C.R.G.), School of Geosciences, University of the Witwatersrand, Private Bag 3, P.O. Wits 2050, Johannesburg, South Africa, [2]Institute of Geochemistry, University of Vienna, Althanstrasse 14, Vienna A-1090, Austria.

Introduction: First order investigations of impact breccias are crucial for furthering our understanding of large meteorite impacts. Thus, an International Continental Scientific Drilling Project (ICDP) recently recovered the Yaxcopoil-1 drillcore from the Chicxulub impact crater, associated with the K/T boundary mass extinction [1,2,3]. Sampling at the UNAM core-storage facility, Mexico City provided 75, 15-30 cm^3, samples. First data presented here regard 1) the petrography of the impactite samples and 2) recommendations to the proposed I.U.G.S. classification [4].

Petrographic approach: Petrographic findings are tabulated in Table 1. They characterize 1) the groundmass of breccias, whether it comprises a polymict breccia, a glass, or a carbonaceous component, 2) the modal percentage, crystallinity, morphology, and grain size of these components, 3) the inclusion type, content, and morphology, 4) the shock metamorphic characteristics, and 5) the superimposed secondary alteration. For correlation, the preliminary macroscopic field description/terminology of Dressler [5] is provided.

Observations: The transition from apparently reworked breccias (containing a distinct carbonate clast component) to suevite, and then to chocolate brown melt breccia is transitional. Samples from these upper to middle units, 794 to 843 m, comprise diverse groundmass material: carbonate, green glass, or a polymict breccia (Table 1). Thin carbonaceous veins filled by fine-grained calcite crystals only cut through the medium-gray, microcrystalline, carbonaceous groundmass, and are more prominent with depth. Green glass, typically present as fluidal-textured, shattered, and vesiculated fragments, can also represent a groundmass as observed in the upper reworked breccia section. Glass color is variable ranging from predominantly green, to brown, dark-gray, and rare orange-red. The green glass fragments may reveal bleached, beige rims and a progressive brown-beige color, changing with depth, towards the chocolate brown melt unit [5]. This package, 818-843 m, contains characteristic magnetite blebs, very limited fossil/limestone clast content, an overall increased consolidation state, a glass fragment size increase (from ~2.0 to <15.0 mm) with preserved primary fluidal glass morphologies, and a lower degree of alteration than the overlying units. Shock metamorphism within this upper package comprises planar deformation features (PDFs), rare ballen structure, and undulose extinction (all in quartz grains).

The middle to lower units comprise horizons composed of brown and green glass, located between 843 and 883 m. Small to large massive brown glass fragments display sharp contacts where the former increases in proportion towards the latter. The brown glass is typically magnetic, occasionally cataclastic, fluidal, and contains non-reflective opaque patches mixed with partially devitrified fine lenses of beige glass. Monomineralic clasts comprise Qtz, Cpx, Opx, plag, and calcite grains. Shock metamorphic features are restricted to PDFs or undulatory extinction in Qtz. Besides the color difference, the lower green glass shard unit, so-called green autogene melt breccia [5], is very similar to the upper brown glass unit in showing fluidal textures and an identical suite of monomineralic inclusions. Shock features comprise distinct checkerboard to partially recrystallized fine-grained plagioclase crystals and ballen structures in Qtz, not witnessed in the overlying brown glass.

The lowermost breccia unit, the variegated polymict, allogenic-clast melt breccia of [5], comprises large glass shards and lithic inclusions set within a carbonaceous groundmass that is occasionally polymictic. Strong carbonatization of this horizon is observed by widespread replacement of precursor carbonaceous components, without any obvious alteration of siliceous glass or basement-derived inclusions being notable. Contacts of carbonate clasts can still be discerned through the alteration. Occasional dissolution vugs are associated with this overprint.

Classification: As described above, the impactite rocks from the Yax-1 borehole contain variable proportions of glass fragments set within a variable groundmass (Table 1). It must be investigatred whether the carbonaceous host could represent an impact melt phase, as interpreted by [6] and observed at other impact craters with carbonate target rocks, e.g. Ries and Haughton [7,8]. According to the proposed classification scheme for impactites by [4], the rocks intercepted in this drill core could all be described as suevites or, possibly, impact melt. However, this would represent a gross over-simplification, as the intricate differences between lithologies (compare Table 1) would not be recorded. It is suggested that this proposed classification scheme be updated so as to distinguish various features found in the Chicxulub impactites. A new graphical ternary classification diagram is proposed with the following end-members: glass, crystalline melt, and lithic contents. This being a textural and modal percentage based representation. Chicxulub impactites dominate the glass apex and fall between the glass-crystalline melt and glass-lithic tie lines, if the assumption of [6] becomes proven through future quantitative petrographic work.

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Depth (m)	Dressler (2002) terminology	Matrix	Vol % carbonaceous mat.	Grain size	Vol% glass	Glass color	Glass characteristics	Vol % clasts	Clast types	Clast shape & size	Shock effects	Alteration	Comments
794.63-805.34	Redeposited suevite	Carbonaceous	30-45	Microcrystalline, <0.05 mm	50-70	Green (dominant), brown, dark gray, orange-red	Vesiculated, angular, to fluidal: 0.12-3.0mm, Avg = 1mm	5	Ls, fossils	Subrounded-subangular, 1.0-5.0mm	PDFs in Qtz	Green chloritization, argillaceous glass alteration	1) A sorted, graded terminal fallback deposit, 2) A reworked breccia by phreatic hydraulic and/or gaseous brecciation, 3) A reworked breccia by resurge processes, 4) a combination of 1-3
808.34-809.00	Redeposited suevite	Carbonaceous	30-50	Microcrystalline, <0.05 mm, with 2 mm veins	50-65	Green (dominant), brown, dark gray, orange-red	Vesiculated, angular, to fluidal: 0.12-3.0mm, Avg = 1mm	5	Ls, fossils	Subrounded-subangular, 1.0-5.0mm	PDFs in Qtz	Strong yellowish-green alteration of the glass component - associated with 1-2mm wide fine-grained calcite veins.	Same as above but with a strong superimposed secondary hydrothermal alteration
809.70-815.80	Suevite	Green glass	30-65	Microcrystalline, <0.05 mm, with 2 mm veins	30-70	Intense green, brown, dark gray	Vesiculated, angular, to fluidal: 0.12-3.0mm, Avg = 1mm	5	Ls	Subrounded-subangular, 1.0-5.0mm	PDFs, ballen structures, undulose extintction in Qtz	Strong yellowish-green alteration of the glass component - associated with 1-2mm wide fine-grained calcite veins.	Same as above but with green glass matrix
816.62-818.23	Suevite	Polymict: glass and carbonaceous material	40-50	Microcrystalline, <0.05 mm, with 2 mm veins	40-50	Green brown, orange-red	Sharp, rounded to angular, 0.12-11mm	10	Ls, dol, qtzite, cryst. basement derived	Subrounded-subangular, 2.0-10mm	PDFs, ballen structures, undulose extintction in Qtz	Green chloritization, argillaceous alteration of the glass component	Same as above but with a disaggregated, polymict groundmass, and relatively larger glass shards
818.23-822.90, 827.13	Suevite	Carbonaceous	50-60	microcrystalline, <0.05mm, to fine-grained, ~0.5-1.0mm	40-50	Green, dark gray, brown, orange-red	Vesiculated, angular, to fluidal: 0.5-15.0mm	Tr.	Ls, dol, qtzite	Subrounded-subangular, 1.0-3.0mm	PDFs, undulose extinction in Qtz	Green chloritization, argillaceous alteration of the glass component	A fallback deposit but with a carbonaceous groundmass
825.43-846.80, 848.25	Chocolate brown melt breccia	Polymict: glass and carbonaceous material	60-70	microcrystalline, <0.05mm, to fine-grained, ~0.5-1.0mm, characterisitic med. gray color	30-40	Green, dark gray, brown, orange-red	Vesiculated, angular, to fluidal: 0.5-10.0mm	1	Basement-derived, monomineralic Qtz, Cpx, opaque blebs	Basement: 2.0-90.0mm, monomineralic inclusions: 0.2-1.0mm, opaque blebs: 0.2-0.5mm	PDFs, undulose extinction in Qtz	Minor green chloritization, argillaceous alteration of the glass component	Same as above but with a polymict matrix:; carbonaceous patches with glass shards, contains a characterisitically blebby opaque phase
848.25, 861.66	Chocolate brown melt breccia, Suevitic breccia, variegated, glass-rich	Brown glass	5	Fine-grained calcite veins	70-95	Brown to light beige	Massive, fluidal, 2.0mm to >3.5 cm	1	Monomineralic Qtz, Cpx, Opx, pg	Subrounded-subangular	PDFs, annealing in Qtz	Brownish, carbonaceous alteration products	A brown glass shard unit that underwent in situ brecciation
861.66-883.41	Green monomict-autogene melt breccia	Yellowish-green glass	10-20	Opaque carbonaceous material	80-100	Yellowish-green	Massive, fluidal, 2.0mm to >3.5 cm	1	Monomineralic, felsic and mafic inclusions (Qtz, Cpx, Opx, plag)	Subrounded-subangular	PDFs, ballen structures in Qtz, checkerboard plag, annealing	Green chloritization, argillaceous alteration of the glass component	A green equant glass shard unit, an incipient melt that underwent *in-situ* brecciation
883.41-894.14	Variegated polymict, allogenic-clast melt breccia	Carbonaceous	90-100	Microcrystalline, <0.05 mm	10	yellowish-green, brown	Angular to subrounded, 2.0-15.0mm	1	Monomineralic Qtz, Cpx, Opx, plag, basement	Subrounded-subangular	PDFs in Qtz	Extensive carbonatization	Extensively altered lower breccia unit with unaltered monomineralic inclusions and glass shards
890.52	Variegated polymict, allogenic-clast melt breccia	Carbonaceous, polymict	30-40	Microcrystalline to fine-grained, <0.05 mm to 0.25mm	60-70	yellowish-green	Angular to subrounded, fluidal internal features, 2.0 - 20.0mm	1	Monomineralic calcite, ls, Qtz	Subrounded-subangular	PDFs in Qtz	Green chloritization, argillaceous alteration of the glass component	Same as above but relatively unaltered, could contain a carbonaceous host melt?